Publications

# TR-138

## Improving Surge Flow Irrigation Efficiency Based on Analysis of Infiltration and Hydrodynamic Effects

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- Full Text

This research investigated the movement of a surface flow profile over an infiltrating soil under conditions of surge flow, and theory related thereto, for use in preliminary design procedures for surge irrigation systems. Four specific research areas were: a) development of a surge flow infiltration model; b) the effect Or wetted perimeter on infiltration in furrow; c) design, construction, and calibration of a physical model of an irrigation border/furrow; and d) development of a surge flow furrow irrigation computer model for use in designing surge flow irrigation systems.

The effect Or wetted perimeter on infiltration in furrows was investigated using field data. Overall, the Kostiakov cumulative infiltration equation, modified to include wetted perimeter raised to a power greater than unity, appeared to satisfactorily represent the effect of wetted perimeter on infiltration in furrows.

The effect of surge flow cycle time and cycle ratio on infiltration in furrows was investigated using a recirculating furrow infiltrometer which simulates surge flow irrigation for various cycle times and cycle ratios. The data collected were used to evaluate two empirical surge flow infiltration models. The effects Of furrow geometry, surface storage, and recession time were considered. The results indicated that infiltration during surge flow irrigation can be effectively described using an empirical model based on the Kostiakov cumulative infiltration equation, the surge cycle ratio, and the surge cycle time.

A physical model of an irrigation border/furrow was constructed using a 61 meter long by 0.76 meter wide tilting flume with a 0.09 meter deep infiltrating gravel bed. The model was partitioned into 15 sections of equal length. Each section contained a small computer controlled submersible pump by which water was uniformly withdrawn from the section through the gravel bed. Real time predictor/corrector computer algorithms were developed to simulate discrete spatially and temporally varying nonlinear infiltration. Each partitioned section also contained an electronic water depth sensor. All 15 water depth sensors are connected to a real time data acquisition system which relays depth of flow information to the computer simulating infiltration. The hydraulic effects of the infiltration simulator partitions, the effect of downstream boundaries on upstream flow depths, and the effect of flow depth and velocity distribution on energy loss were investigated.

A computer model Or surge flow hydraulics and infiltration was developed for the preliminary design of surge flow systems. The model is based on the kinematic wave assumptions for overland flow, and the cycle ratio-time infiltration model developed during this research project. Hypothetical irrigation simulations indicate that for some high intake rate soils, surge flow has potential for markedly improving distribution efficiency over conventional continuous irrigation. However, the model also indicated that an improperly operated surge flow system can actually have lower efficiency than a continuous flow system; this factor is seldom mentioned in literature on surge irrigation.

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